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Recognition of the Role of Water in Rural Development of Arid Regions Using Morris Model and Correlation Analysis: A Case Study in Larestan, Iran

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Abstract

Today, conservation and optimal utilization of water resources is an important global issue. Especially, in the arid regions sustainable usage of water is a critical and vital matter. Recognition and analysis of various aspects of this problem and being aware of it can promote extraction and optimal usage of water. In this study the role and significance of water in rural development of the southern region of Iran – Larestan – will be discussed. After dividing this region into seven rural systems and evaluation of their development based on Morris Model, the correlation coefficient between rural development and water (annual precipitation and groundwater quality) was calculated. The result is that, unlike the insignificance correlation between development and annual precipitation, but the degree of development of rural systems in Larestan has high correlation with groundwater quality. Therefore, strategies for extraction and optimal usage of groundwater would provide new capacities for further development.

Keywords: Larestan, Morris Model, Rural Development, Water Correlation and Development

Introduction

Exploitation of water resources causes life and activity of human communities and it is an important factor to organize rural settlement and the sustainability of these communities. Today, preservation and optimal utilization of water are the global issues. Especially in the arid regions, sustainable usage of water, it is a critical and vital matter which has been taken into account by many researchers. As an example, Salahi Esfahani studied the role of water and irrigation in the sustainable development of Akhtarabad-Hakimabad rural region located in the center of Iran and came to this conclusion that between characteristics of natural and social environment and water and irrigation issues aimed at improvement of living conditions, a flow will be formed which is called an effort to achieve rural sustainable development (Salahi Esfahani, 2007, 74). Yasouri studied the role of limitation of water resources on instability of rural settlements in Khorasan Razavi, and emphasized that since water is considered as a focal factor in the rural economy of Khorsan, any planning for establishing population and activities should be commensurate with the ability of water resources of districts (Yasouri, 2007, 174). Mortazavi et al. studied the effects of inefficient management of water resources in Rafsanjan plain and concluded that raising salinity causes soil subsidence and a lot of damages to home and infrastructures as well as sharp drop in the level of groundwater as the result of non-systematic withdrawal of groundwater resources are part of problems due to unsystematic management on water resources (Mortazavi et al., 2011, 131). Fallahtabar and Boheiraei studied the effects of water resources on the development of arid region of Kashan and concluded that if no main action has been taken to protect water resources, the sustainable development route of this region will encounter the most important obstacle meaning lack of water (Fallahtabar & Boheriaei, 2012, 226).

In this study, the goal is to assess the impact of water resources on rural development degree. On the other hand, the aim is to assess the correlation of rural development with the quality and quantity factor of water resources using qualitative method. Although this seems obvious and the relationship between water and village is a proverb, but basically and according to the qualitative and statistical models, the degree of this correlation has strengths and weaknesses in various districts. Moreover, throughout the world there are regions and countries that despite having various raw materials and sufficient water and soil resources, but they are in backwardness and underdevelopment state. In other words, with the existence of a resource such as water, we cannot conclude that the development will be followed. It should be clear that in the development of a given region, water is an effective variable or not. Therefore, first we determine the degree of development in various rural regions of Larestan based on Morris model and then the correlation coefficient between final index of development of regions and water factor will be assessed.

The Study Region

Larestan is located in the South part of Iran between 52° 45′ to 55° 38′ E longitude and 27° 15′ to 28° 22′ N latitude. This county has an region of 14352 square kilometer. Lar, the political capital of Larestan has been located at the distance of 330 kilometers of Shiraz and the direct distance of 110 kilometers of Persian Gulf.

Materials and methods

Research method is a combination of geographical descriptive methods and statistical analysis. The geographical aspect of this research is to study the relationship between human and environment in a given region with the emphasis on water factor. The statistical analysis methods are applied to calculate the degree of correlation between the levels of rural development and water factor so that the role of water is explained in rural development and the significance of the application of modern methods of water extraction and consumption management be emphasized. Therefore, Larestan is divided into a few small rural regions or systems. In the following stage, these regions will be ranked based on development ***indices*** using Morris technique and the correlation coefficient between final index of Larestan rural systems development and water factor (precipitation and groundwater resources) will be calculated. Therefore, given the degree of rural systems development as a criteria resulted from Morris technique and using correlation analysis, the degree of the effect of water factor on the development of rural systems will be evaluated.

Morris model specifies the development status of each unit using available data for each settlement based on the selected index and finally determines the average sum of index by analytical method development index in such a simple but striking way and then ranked settlements (Badri, Akbarian & Javaheri, 2006, 121). Morris coefficient of expansion varies between 0 to 100 and the closer range to 100 is, the more developed level will be (Rezvani, 2004, 154). After determining the final development coefficient, the regions will be ranked using the achieved coefficient such that the region with higher coefficient has the first rank and then other regions will be ranked accordingly (Azadi & Beikmohammadi, 2012, 50). The process and implementation of Morris model and calculation of the related coefficient are as follows:

First Step) Setting index value for matrix and regions of study such that the regions or settlement is written in one column and the amount of index are written in another column.

Second Step) Standardizing all selected numbers using Morris deprivation coefficient formula and replacing standard number instead of previous numbers:

$$y_{ij} = \frac{x_{ij} - x_{jmin}}{x_{jmax} - x_{jmin}} \times 100 \qquad (1)$$

In the mentioned formula, y_{ij} is the standardized number of index, x_{ij} is the real number of index, x_{jmin} is the smallest numner of each column and x_{jmax} is the largest number of each column. The result of this formula indicates the deprivation that each region has based on the defined indices. As stated before, this deprivation is ranged between 0 to 100 in which 0 is the maximum deprivation and 100 is the minimum deprivation.

Third Step) Calculating final coefficient by the following formula achieved for all regions separately:

$$D.I = \frac{\sum y_{ij}}{N} \qquad (2)$$

On the other hand, in this step, the standardized amount of indices is determined.

Forth Step) Ranking regions using final development coefficient such that the larger the D.I is, the more developed and the more equipped the region will be (Hajializadeh, Mahdavi & Kordovani, 2010, 4) and (Faraji, Molaei, Azimi and Zayari, 2010, 5). As noted above, using Morris model in this research and obtaining the related result depend on a correlation analysis.

Discussion and Conclusion

The region of study is divided into sub-regions which can be called rural systems. In this study, the rural system is a collection of villages, rural regions, farms and places located in a given catchment region and often in the middle of plains and foothills of that catchment. The common feature of the systems is that each system has been located in a given field with the shared water resources and creates a geographical system. The mountainous nodes and uninhabited lands fill the distance between Larestan rural systems. Putting into account the above criteria and the goals of this study, we can divide and define seven separate systems with distinct features. These systems include Jooyom, Hood, Sahra e Bagh, Beiram, Dahkooy, Saiban and Aliabad.

Table 1: Matrix of indices & standardized amount and final development index of rural systems of Larestan based on Morris Model

Final Index		Economic		Cultural		Services		educational		Health		Rural Systems
Final Rank	Personal amount	Standard amount	Personal amount	Standard amount	Personal amount	Standard amount	Personal amount	Standard amount	Personal amount	Standard amount	Personal amount	
3	48.77	15	11	33.33	16	73.33	61	66.66	24	55.55	21	Jooyom
2	74.03	85	25	52.38	20	55	50	100	30	77.77	27	Hood
1	98.89	100	28	100	30	100	77	94.44	29	100	33	Sahra e Bagh
4	48.75	65	21	47.62	19	70	59	50	21	11.11	9	Beiram
6	20.42	35	15	9.52	11	15	26	27.77	17	14.81	10	Dehkooy
5	45.85	0	8	66.66	23	70	59	55.55	22	37.04	16	Saiban
7	0	0	8	0	9	0	17	0	12	0	6	Aliabad

Source: Author’s Calculations

In order to adjust Morris table, the required data from villages and rural regions of Larestan were gathered from various resources. After primary study of data and fulfilling preliminary calculations, table (1) was drawn up and development indices of rural systems development of Larestan were calculated based on Morris model.

The correlation between the level of development and average of annual rainfall: In this stage, in order to calculate correlation, the data resulted from Morris model and average of annual precipitation of Larestan rural systems have been inserted in table (2).

Table 2: Base data to calculate correlation between precipitation and development

Aliabad	Saiban	Dehkooy	Beiram	Sahara e Bagh	Hood	Jooyom		
175	153	201	201	168	216	212	Average of annual precipitation(mm)	X
0	45.85	20.42	48.75	98.89	74.03	48.77	Morris development index	Y

Source of precipitation information: State Meteorological Organization. Meteorological Yearbook: 1989 to 2013

The correlation coefficient was calculated by SPSS software. The precipitation as an influencing and independent variable, and development as a dependent variable were selected. In order to study the relationship between level of development and average of annual precipitation, three bivariate correlation tests were used. First, Pearson correlation coefficient was calculated and then Spearman and Kendall nonparametric tests which are calculated based on score rank was done and various correlation coefficient was achieved. In regard to Pearson, the correlation coefficient equal to 0.42 was obtained which are not significant: $(r = 0.42 \quad Sig > 0.05)$.

Table (3) includes summary of calculations of correlation coefficient between precipitation and development using Pearson method.

Table 3: The Output of SPSS program in regard to Pearson Correlation Coefficient between precipitation and development

Annual precipitation	Morris development index		
.422	1	Pearson Correlation	Morris development index
.346		Sig. (2-tailed)	
7	7	N	
1	.422	Pearson Correlation	Annual precipitation
	.346	Sig. (2-tailed)	
7	7	N	

Also, in regard to Spearman and Kendall coefficient, the results are not significant.

$(\rho s = 0.43 \quad Sig > 0.05)$ $(\tau = 0.29 \quad Sig > 0.05)$

Considering the results, we found no correlation between the amount of annual precipitation and degrees of Larestan rural systems development (tables 4 & 5).

Table 4: The Output of SPSS program in regard to Spearman correlation coefficient, between precipitation and development

Annual precipitation	Morris development index			
.432	1.000	Correlation Coefficient	Morris development index	Spearman's rho
.333	.	Sig. (2-tailed)		
7	7	N		
1.000	.432	Correlation Coefficient	Annual precipitation	
.	.333	Sig. (2-tailed)		
7	7	N		

Table 5: Output of SPSS program in regard to Kendall correlation coefficient, between precipitation and development

Annual precipitation	Morris development index			
.293	1.000	Correlation Coefficient	Morris development index	Kendall's tau_b
.362	.	Sig. (2-tailed)		
7	7	N		
1.000	.293	Correlation Coefficient	Annual precipitation	
.	.362	Sig. (2-tailed)		
7	7	N		

Also, by studying correlation graph, it is clear that the relationship between two variables is not significant.

The correlation between level of development and groundwater quality: In order to calculate correlation, the data resulted from Morris model and average of groundwater quality of Larestan rural systems have been inserted in table (6).

Table 6: Base data to calculate correlation between groundwater quality and development

Ali abad	Saiban	Dahkooy	Beiram	Sahra e Bagh	Hood	Jooyom		
9600	4650	4075	5986	2057	3750	3500	The average of the groundwater quality (***electroconductivity*:** micromhos/centimeter)(	X
0	45.85	20.42	48.75	98.89	74.03	48.77	Morris development index	Y

Source of water resources information: Fars Regional Water Organization

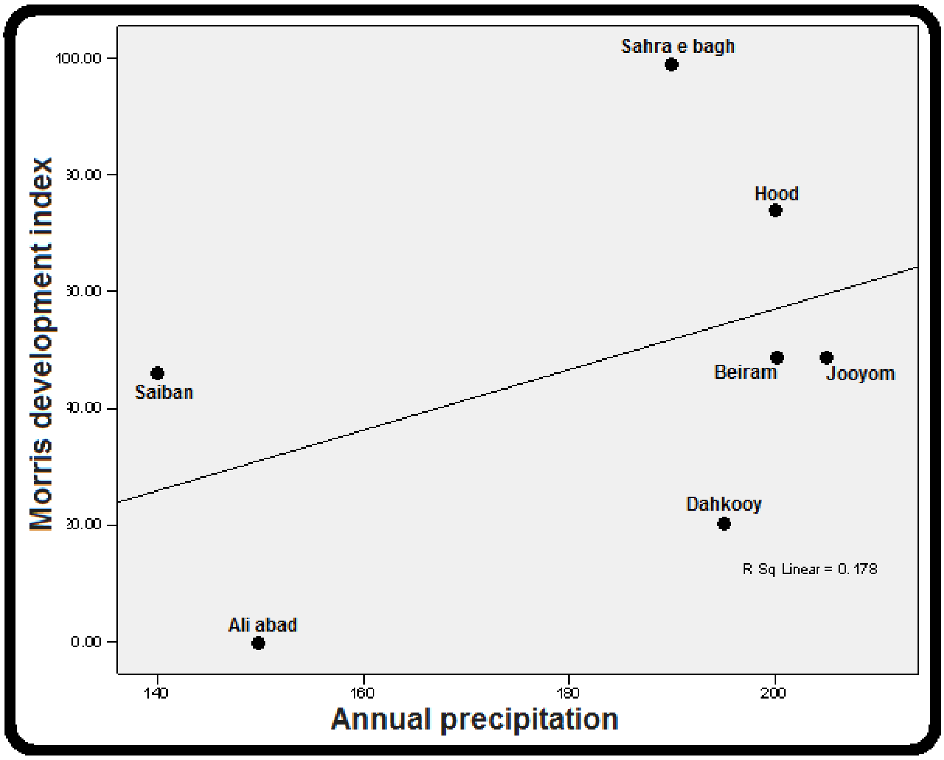

Figure 1: Correlation between precipitation and development in Larestan

The groundwater quality as an influencing and independent variable, and development as a dependent variable were considered. In order to investigate the relationship between variables of level of development in rural systems and groundwater quality, bivariate correlation analysis including Pearson correlation and Spearman and Kendall nonparametric test which is calculated based on score ranks were used and the correlation coefficient with the approximate amount were achieved. In regard to Pearson, it is worth mentioning that the correlation coefficient equal to -0.81 was obtained and the relationship in level 0.05 is significant at the %95 confidence interval. (Sig=0.027) (Table 7)

Table 7: Output of SPSS program in regard to correlation coefficient, between groundwater and development

Mean of water quality	Morris development index		
-.810(*)	1	Pearson Correlation	Morris development index
.027		Sig. (2-tailed)	
7	7	N	
1	-.810(*)	Pearson Correlation	Mean of water quality
	.027	Sig. (2-tailed)	
7	7	N	

* Correlation is significant at the 0.05 level (2-tailed).

Also, with regard to Spearman and Kendall coefficient, the same result as of Pearson was obtained (-0.85 and -0.71 respectively). With these results, we can infer that there is correlation between water quality and degree of rural development, and by increasing groundwater quality, the level of development will improve. On the other hand, by increasing water conductivity resulted from proliferation of various salts, the level of development is decreased and type of correlation is negative.

Table 8: Output of SPSS program in regard to Spearman correlation coefficient, between groundwater quality and development

Mean of water quality	Morris development index			
-.857(*)	1.000	Correlation Coefficient	Morris development index	Spearman's rho
.014	.	Sig. (2-tailed)		
7	7	N		
1.000	-.857(*)	Correlation Coefficient	Mean of water quality	
.	.014	Sig. (2-tailed)		
7	7	N		

*Correlation is significant at the 0.05 level (2-tailed)

Table 9: Output of SPSS program in regard to Kendall correlation coefficient between groundwater quality and development

Mean of water quality	Morris development index			
-.714(*)	1.000	Correlation Coefficient	Morris development index	Kendall's tau_b
.024	.	Sig. (2-tailed)		
7	7	N		
1.000	-.714(*)	Correlation Coefficient	Mean of water quality	
.	.024	Sig. (2-tailed)		
7	7	N		

*Correlation is significant at the 0.05 level (2-tailed)

By visual study of correlation graph, we found an inverse correlation close to linear between Morris development index and groundwater ***electroconductivity*** capability. In other words, by increasing EC numbers, development index scores are deducted (figure 2).

The result is that the development of Larestan rural systems has no correlation with the average of annual precipitation, but it has high correlation with the groundwater quality. In other words, uncertainty to precipitation resulted from its high coefficient of variation causes the dependency of the activity and living in the villages of Larestan on the extraction of groundwater with the used quality. Therefore, considering high dependency of rural development and groundwater factor, it can be judged that if these sources are used in a best way, the new capacities for more development will be provided. So, Larestan is among regions where its rural development is so sensitive in comparison with water factor and in case of obtaining extraction ways and optimal usage of water and its more access, we can accelerate the process of rural development.

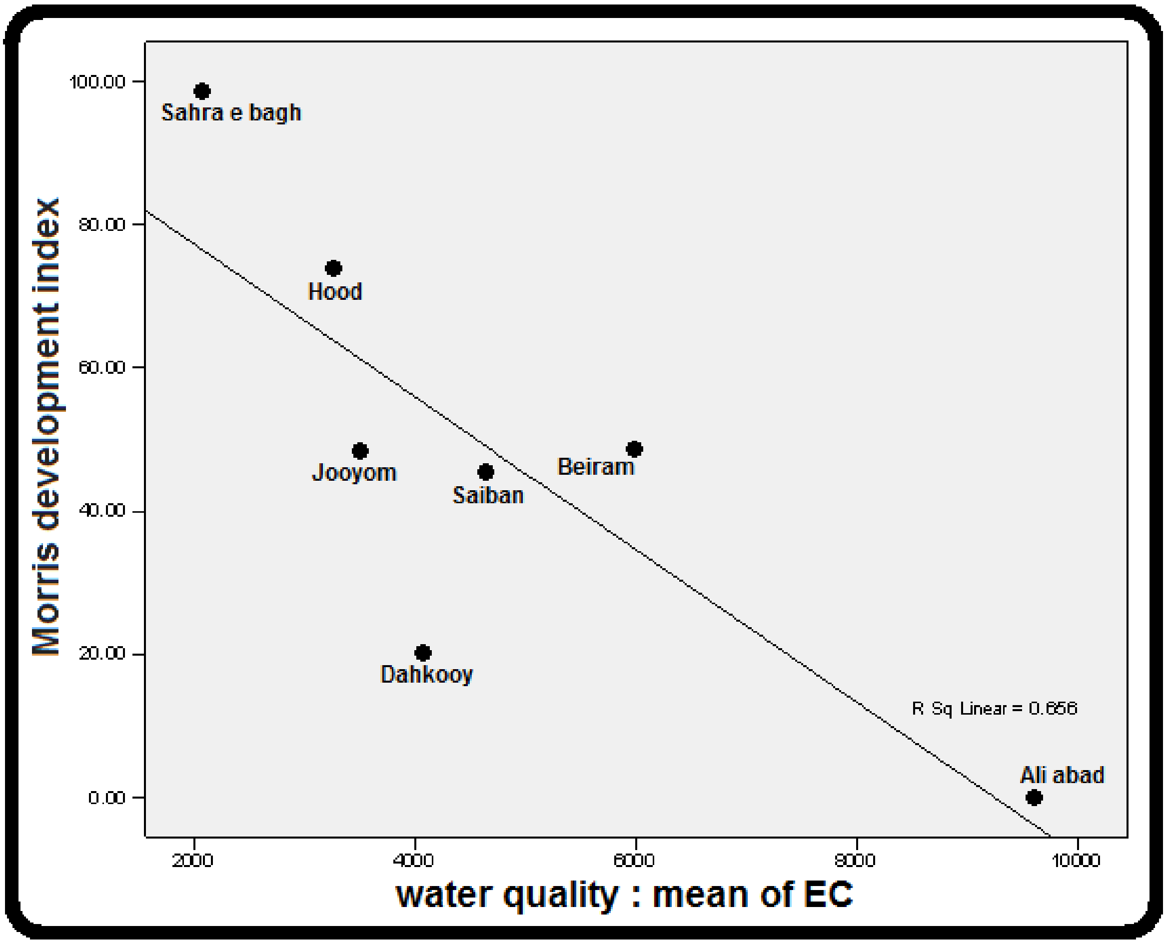

Figure 2. Correlation between groundwater quality and development in Larestan

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